

Name: Solution

Midterm Exam Winter 2006 (ECE 261)

1. [3 points] a) What is the exact number of bits in a memory that contains 2M bits?

$$2 \times 2^{20} = 2^{21} = 2,097,152$$

- b) What is the number of different minterms in a 3-variable map?

$$8 = 2^3$$

- c) What is the dual of $Y + XY$?

$$Y(X + Y)$$

2. [6 points] Convert the following numbers from the given base to the other two bases in the table:

| Binary | Decimal | Octal |
|------------|---------|-------|
| 101.001 | 5.125 | 5.1 |
| 1010.0101 | 10.3125 | 12.24 |
| 101111.001 | 95.125 | 137.1 |

3. [4 points] Perform the following operations with the binary numbers $X=10111$ and $Y=10$ (Do not convert the numbers to another base.)

- (a) $X - Y$ (subtraction)

$$\begin{array}{r} 10111 \\ - 10 \\ \hline 10101 \end{array}$$

- (b) $X * Y$ (multiplication)

$$\begin{array}{r} 10111 \\ \times 10 \\ \hline 00000 \\ + 10111 \\ \hline 101110 \end{array}$$

4. [3 points] Simplify the following Boolean function (considering also the don't care conditions) to a sum-of-products:

$$F(A, B, C, D) = \sum m(5, 6, 7, 13)$$

$$d(A, B, C, D) = \sum m(0, 1, 4, 15)$$

| AB \ CD | 00 | 01 | 11 | 10 |
|---------|----|----|----|----|
| 00 | X | X | | |
| 01 | | 1 | 1 | 1 |
| 11 | | 1 | X | X |
| 10 | | | | |

$$F(A, B, C, D) = B(C + D)$$

5. [3 points] Simplify the following Boolean function (considering also the don't care conditions) to a product-of-sums:

$$F(A, B, C, D) = \prod M(1, 3, 4, 6, 9, 11)$$

$$d(A, B, C, D) = \sum m(0, 2, 5, 10, 12, 14)$$

| AB \ CD | 00 | 01 | 11 | 10 |
|---------|----|----|----|----|
| 00 | X | 0 | 0 | X |
| 01 | 0 | X | | 0 |
| 11 | X | | | X |
| 10 | | 0 | 0 | X |

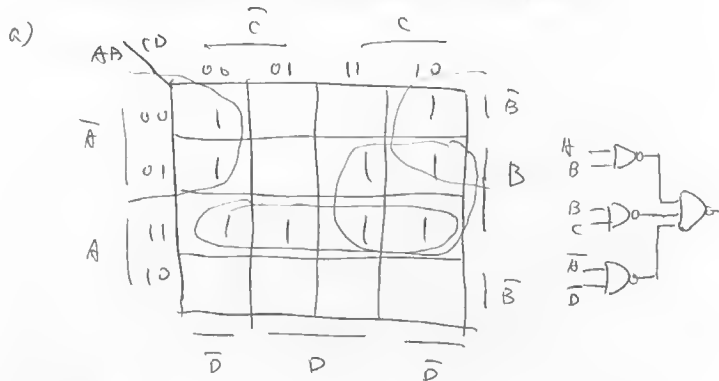
$$F(A, B, C, D) = (\bar{B} + D)(B + \bar{D})$$

$$\text{or } (A + D)(B + \bar{D})$$

6. [6 points] Using a K-map simplify the following Boolean function:

$$F(A, B, C, D) = AB + BC + \bar{A}\bar{D}$$

and implement the result with (a) NAND gates only, and (b) NOR gates only.



$$\therefore F = \bar{A}\bar{D} + AB + BC$$

